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ASSESSING THE RESIDENTIAL LIGHTING EFFICIENCY OPPORTUNITIES IN GUADALAJARA AND MONTERREY, MEXICO

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Abstract—Lighting, primarily with incandescent bulbs, is the major end use of electricity in Mexican homes. The introduction of compact fluorescent lamps (CFLs) could significantly reduce electricity use in lighting. We describe a survey of lighting use in homes of Guadalajara and Monterrey, Mexico, that was conducted to provide information to determine the potential for CFLs. The results show that 1/6 of the incandescent bulbs can be replaced with CFLs if only those bulbs used more than 4 hours per day are targeted. We also provide insights on conducting similar surveys in other developing countries.

INTRODUCTION

Developing countries are facing increasing residential electricity demand. To understand better how the residential demand may evolve in the future, it is necessary to know how electricity is being used. Surveys of household energy use are the prefered data gathering method. Lighting has been found to be the largest end-use of residential electricity in many developing countries.[1–5] Most developing country surveys have focused on quantifying the major end uses of residential electricity without examining time-of-use. A study in India reported different time-of-use patterns for fluorescent and incandescent lighting in Bombay homes.[1] Studies in Norway and the U.S. have also examined time-of-use issues in residential lighting.[6,7] Thus there appears to be very little public information on household lighting patterns in developing countries. As these countries strive to reduce growth in residential electricity demand, they will require a better understanding of how homes use their electricity. This paper not only provides information on lighting in two Mexican cities, but also discusses issues on survey design and implementation which will be of use to other similar efforts. The lighting use results discussed here can be expanded to the rest of Mexico and to a lesser degree to Latin America. The general survey implementation issues should be useful for other practitioners in developing countries envisioning similar surveys.

Residential electricity use is a significant portion of current Mexico electricity demand, and its share is increasing with time. In 1992, the 15.9 million residential customers used 24 TWh (about 25% of total electricity sales) and accounted for about one-third of the peak load of 19 GW.[8,9] Annual growth of residential demand averaged 7.3% between 1980 and 1992.[8,10] Future growth in residential electricity use will be due to the continued rural electrification, construction of new homes, and increased ownership and electricity intensity of appliances.[11] About 91% of homes are already electrified,[8] but that still leaves 89 thousand rural communities and 7.6 million people without electricity.[8] Appliance saturation in 1987 was about 58% for refrigerators, and 77% for televisions.[12] The average size of refrigerators is small at 300 liters (10 ft^3) and most have manual defrost.

The contribution of residential lighting to electric energy and peak power demand has been estimated to be 8.3 TWh and 2.6 GW; about 38% of total residential electricity demand and 14% of system peak load.[9] Incandescent lamps provide almost all of the residential lighting, as was found in Venezuela and

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in sharp contrast to Asian countries, where a significant portion of residential lighting is fluorescent.[13–15] This presents an opportunity for replacement of incandescent lamps with more efficient compact fluorescent lamps (CFLs), which only use between 1/4 and 1/3 of the electricity to provide the same amount of light. Estimates of the savings possible from nationwide promotion of CFLs are 2.1 TWh and 1.2 GW by the year 2000.[16]†

Mexico's national public utility, the Comisión Federal de Electricidad (CFE), has been promoting the use of compact fluorescent lamps since 1990.[17] Most of the projects to date have been small (between several hundred to several thousand CFLs). The first three projects (in Hermosillo, Puebla, and Queretaro) were testing the impact of the CFLs on the grid. The CFLs were given to customers free of charge in these three projects. The next four projects (in Valladolid, Chetumal, Hermosillo II, and for CFE workers in Mexico City) served to test various outreach and implementation approaches. CFE is about to begin a much larger project in Aguascalientes (a community of about 100,000 homes, of which about 55,000 will be targeted to introduce about 164,000 CFLs) to gain experience for Ilumex, a full-scale project.[18] Ilumex will seek to introduce 1.5–2 million CFLs in Guadalajara and Monterrey (Mexico's second and third largest cities).[16] Ilumex is slated to begin in June 1994, when funding in the form of a loan from the World Bank together with grants from the Global Environment Fund and the Norwegian government is expected to become available.

This paper describes the results and implementation issues of a survey of residential customers conducted in the cities of Guadalajara and Monterrey as part of a feasibility study of Ilumex done by LBL in conjunction with the International Institute for Energy Conservation. The economics of Ilumex are discussed by Sathaye et al.[19] This paper has two purposes: (1) report the salient results of the survey regarding lighting in these two Mexican cities and the potential for their replacement with CFLs; and (2) describe the insights gained in the implementation of the survey that will be of use to other practitioners envisioning similar surveys in other countries.

SURVEY PURPOSE AND IMPLEMENTATION

The purpose of the survey was to estimate the electricity savings potential for Ilumex by determining the amount, wattage, and hours-of-use of incandescent lamps that could be replaced with CFLs in the two cities. The survey gathered this information across all tariff classes. These are aggregated for analysis into three residential customer classes: low, medium and high electric consumption. In addition, the survey gathered information on electric appliances. Survey implementation comprised selection of a Mexican counterpart to conduct the survey, designing and testing of the questionnaire, definition of the survey sample, hiring and training of surveyors, the survey itself, and data entry and analysis. Each of these tasks is briefly described below.

Surveyor contracting

Contacts in Mexico were queried to get names of organizations who could conduct the survey. Competitive proposals were invited from these organizations. We preferred, and succeeded in getting, university engineering or marketing students as enumerators. Engineering students would understand the technical aspects of the CFLs while marketing students would have survey experience. Using students would reduce costs and also serve to train Mexicans in energy efficiency surveys for future efforts. The Centro de Estudios Energéticos A.C. (CEE; Center for Energy Studies) of Mexico City was selected to do the survey. CEE had previous experience in energy end-use surveys in Mexico and also was the only organization, of the seven who submitted proposals, that could do both cities.

Questionnaire design

The next task was the design of the survey questionnaire. A draft questionnaire was prepared after consulting CFE, CEE, and U.S. members of the Ilumex feasibility project who had extensive experience with similar surveys in the U.S. and elsewhere. This questionnaire was then pre-tested in the field to examine its applicability, both in content, and ease and length of time required to fill it out. The pre-

†These savings result from the replacement of all incandescent bulbs used a minimum of 4 hours per day, of at least 40 W, and in fixtures that easily allow use of CFLs. If incandescent bulbs used at least 2 hours per day are replaced, then the savings reach 2.2 TWh and 2.6 GW.

test corroborated that one customer could be surveyed in less than 30 minutes. The final version of the questionnaire consists of four parts: (1) first page for general customer information; (2) a table that covers current lighting equipment and its usage patterns, and another page with questions on consumer attitudes to CFLs and previous familiarity with them; (3) a table that covers electric appliances and their usage patterns; and (4) a page for survey evaluation by both the surveyor and the supervisor.

Survey sample

The sample selection may be done in one of two different ways: (1) using a representative population neighborhood, and (2) using a geographically stratified approach. In the first case, census data are used to pick representative neighborhoods that are then surveyed extensively. In the geographically stratified approach, the whole area of the city is surveyed and homes in each area are picked in such a manner that they represent the entire range of household energy consumption.

For Ilumex, the geographically stratified approach was used. This method has been widely used in similar efforts in Asian countries.[1,15] Geographical issues such as age of the neighbourhood and to a lesser degree microclimate (particularly hill versus valley) are captured. To implement a survey sample using the geographically stratified approach, a listing of utility customers was prepared by CFE. Each city was divided into different geographical areas identical to CFE's own division of the city by agencies (14 areas in Guadalajara and 10 in Monterrey). For each area, a list of every thousandth user plus 4 alternates (two users immediately above and below) was prepared in ascending or descending order according to their electricity consumption. These sublists were then put together by picking adjacent geographical areas and combining them in an ascending–descending–ascending, etc. pattern. The final survey sample lists prepared by CFE had 2400 customers in Guadalajara (480 target homes) and 2630 consumers in Monterrey (526 target homes).

The survey

The target households were informed that a survey was taking place with an official letter that CFE prepared and distributed. However, due to time and personnel constraints, the letter did not reach all the households before the survey. This lack of initial notification was worrisome in view of some negative experiences encountered in Guadalajara during the test of the questionnaire, where a deep distrust of strangers was evident in a significant portion of the surveyed homes. In Monterrey no such distrust was found, partly due to CFE informing customers of the impending survey, and due to CFE's prior promotion of energy efficiency. Nevertheless, access into the homes in Guadalajara was not compromised by the lack of previous notification. CFE prepared identification badges and letters of introduction for the surveyors. These measures were aimed at allaying customers suspicions of surveyors, enhancing entry to the homes.

CFE prepared 50 attache-cases carrying five different CFLs each that were used by the surveyors to demonstrate the CFLs to the customers during the survey. Additionally, FIDE (a fund set up for the financing of energy savings schemes), bought another 1000 CFLs to give one CFL to each customer surveyed. A future telephone survey will query these customers on their satisfaction with these CFLs. Hiring of students as surveyors was done by CEE. The students were paid a fixed amount per accepted survey (about US$7). A daily stipened of another US$2 was given to cover transportation and meals. Surveyors underwent one-day training to familiarize them with the CFLs, technical aspects (so they could answer questions customers might ask), and on interviewing techniques. Training was done by CFE personnel who had been involved in previous CFE programs of CFL dissemination elsewhere in Mexico. Twenty-six students from the Centro de Estudios de Opinión of the University of Guadalajara were hired in Guadalajara and 13 students, mostly from the Tecnológico de Monterrey, were hired in Monterrey. All the Monterrey students had access to automobiles while the Guadalajara students relied on public transportation.

Due to time and budgetary constraints, the survey was done in 1 week.† This severely strained the capability of the CEE and also jeopardized quality control. The two supervisors spent a good part of their time dealing with other administrative activities. Some of us believed a priori that the survey should be done by teams comprising two surveyors (a woman and a man) of mixed backgrounds

†The results of the survey were needed for the economic feasibility analysis of Ilumex whose final results were needed in time for the World Bank's Board of Governors meeting where approval of Ilumex grant and loan package would be sought.

(engineering and marketing). Limited resources and the experiences of the pre-test indicated that one surveyor per home would probably suffice. The use of one surveyor per home did not pose problems to the survey itself. Surveyors were told to follow a specific method in deciding which alternate address to go to if the initial targeted home was unavailable (preferable immediately below, then immediately above in one case, and in the next situation, first immediately above and then immediately below). Significant problems were encountered in Guadalajara, partly because some addresses in the survey sample list could not be found. This problem had also been experienced in the pre-test. Completed questionnaires numbered 478 in Guadalajara (of these 351 were from first-preference samples), and 498 in Monterrey (of these 399 were from first-preference samples).

Data analysis

The surveys were examined in CEE's Mexico City offices for completeness. Only 28 surveys were invalidated in Guadalajara. In Monterrey, two surveyors were found to have been doing an impossible number of surveys each day (over 30). They were fired midstream and all their surveys were invalidated. Thus, the data analyzed according to consumption level refers only to 345 surveys in Guadalajara and 348 surveys in Monterrey. Data on consumer attitudes are based on all of the surveys or 450 for Guadalajara and 405 for Monterrey.

The survey data were entered into computers and analyzed by CEE. The data on number of lamps, wattage of lamps, retrofitability (i.e., appropriate fixture for CFL using at least a 20 W incandescent for at least 2 or 4 hours per day), and patterns of daily use were analyzed on personal computers using relational database, and commercial statistical and spread-sheet packages. Some of the data were further analyzed at LBL subsequently.

SURVEY RESULTS

The key results of the survey are shown in Table 1. Monterrey, a more affluent city, has more lamps per home (11.1 to Guadalajara's 8.7), with a slightly lower average wattage (66.8 to Guadalajara's 67.5 W/light). Monterrey also has a larger number of potential CFL opportunities per home (1.8 to Guadalajara's 1.3 at 4-hour per day use, and 3.4 to 3.2 at 2-hour per day use). Based on the survey,

Table 1. Survey results for replaceable incandescent lamps.

GUADALAJARA

Electric use (kWh/month)	Number of households in sample	Lamps per household	Replaceable lamps per household			Total CFLs possible (10^3)	
			Total	4 h/day	2 h/day	4 h/day	2 h/day
0 →150	221	7.9	5.34	1.28	3.05	549	1307
151 → 300	106	10.2	6.21§	1.48§	3.46§	160	372
301 →	18	9.9‡	6.21§	1.48§	3.46§	47	110
Total	345	8.7	5.60	1.34	3.16	756	1788

MONTERREY

Electric use (kWh/month)	Number of households in sample	Lamps per household	Replaceable lamps per household			Total CFLs possible (10^3)	
			Total	4 h/day	2 h/day	4 h/day	2 h/day
0 → 175	181	7.7	5.24	1.43	2.93	486	999
176 → 350	116	13.1	6.67	1.80	3.66	268	544
351 →	51	18.8	10.20	2.98	5.92	176	351
Total	348	11.1	6.16	1.78	3.61	931	1894

†Replaceable incandescent lamps are those of at least 40 watts, located in fixtures that permit replacement with compact fluorescent lamps. ‡We believe that this value is low and a result of under-reporting by surveyed homes. §These values are an average of the results obtained for both consumption levels.

the total number of CFLs that would be possible to introduce in both cities was between 1.7 and 3.7 million. Thus, Ilumex's target of 1.5–2 million CFLs seems to be appropriate.

The number of lamps that could be replaced with CFLs was obtained by determining those lightpoints fitted with incandescent bulbs (87% in Monterrey, 97% in Guadalajara), which were at least 40 W size, and were in a fixture that was physically retrofitable (about 88% of incandescent bulbs in Monterrey and 83% in Guadalajara). It is interesting to note that in Monterrey, 77% of the lamps were in an open (non-sconce) fixture in the ceiling and only 4% were hanging by a wire, while in Guadalajara only 29% of the fixtures were of the open type and 45% were hanging from a wire. The retrofitable lights were then further culled for the number of hours they were on during the day. Lights used for more than 2 or 4 hours per day were counted to determine the number of retrofitable opportunities that were economically viable. The largest number of fixtures were in the bedroom (36% in Monterrey and about 40% in Guadalajara), with significant amounts in the kitchen (14 and 13.5%), bathrooms (13.5 and 14%), living room (8 and 11%) and dining room (8 and 9%). The garage had only 1.6–2.4% of the fixtures, but these were used for many hours, including the peak evening hours. The bedroom, kitchen, and bathroom were also extensively used during the evening peak hours. Although the living room had a significant number of the fixtures, few of its lights were retrofitable since in general they were decorative ceiling lamps.

Figure 1 shows the hours of use of lights in both cities corroborating the hypothesis of residential lighting's importance during the utility's peak load hours (between 7 and 11 p.m.). The sharp increase in lighting use during the peak load hours, in particular the main 2-hour peak, presents an important potential for the reduction of this electricity load. This is consistent with similar data reported for other cities from other surveys.[1]

As expected, the survey showed that the number of bulbs replaceable with CFLs increases with electricity consumption.† The results show that a significant percentage of the CFL introduction opportunities will be found amongst the higher consumption customers. In Monterrey, about 48% of the replacement opportunities occur in households using more than 175 kWh/month. In Guadalajara, 27% of the CFL opportunities occur in households using more than 150 kWh/month. This suggests that

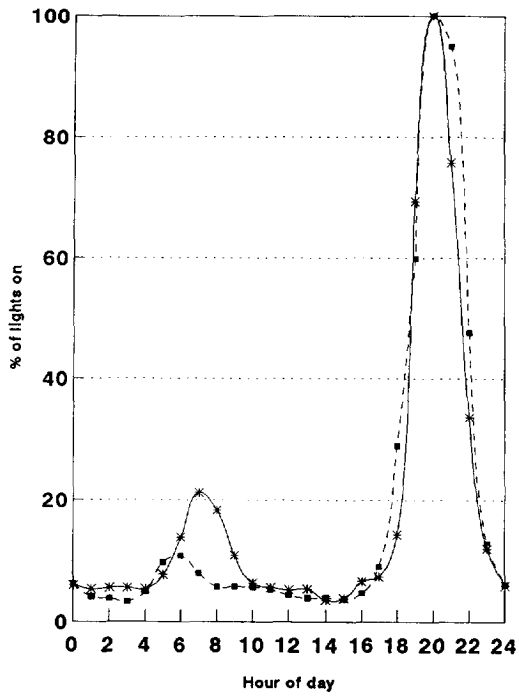

Fig. 1. Percentages of the total lights used during the day in Guadalajara (*) and Monterrey (■).

†In Guadalajara, an exception was found for the highest consumption class. We believe that in this case the relatively low number of lamps per household at the highest consumption level resulted from too small a sample in that class. We therefore used the same value for replacement as was obtained for the middle range customers.

CFE's policy of targeting low-income households and its desire of obtaining greatest reductions in peak demand can not be simultaneously met for the currently envisaged project size. Once the target lamp-points in low-income households have been replaced, those in higher-income households must be replaced to achieve further economic reductions in peak demand.

If Ilumex is successful, the 1.5 million CFLs could reduce peak load by 78 MW and reduce electric generation by 135 GWh annually (assuming 50.4 W saved per CFL, 4 hours-per-day of use, peak and average load transmission and distribution losses of 22 and 18%, and peak coincidence factor of 80%).

The survey results can be useful when planning other residential CFL projects in Mexico. Tariff structure in Guadalajara can be likened to most large non-Northern Mexican cities, i.e. about 12 million electrified households, while tariff structure in Monterrey approximates the hotter northern states, or about 4 million households.† From the survey's results, one can expect, for a 4 hour per day minimum use, only 1 in every 6 bulbs to be retrofitable with a CFL. For a 2 hour per day use, this increases to around 1 in every 3 bulbs. Most of the retrofitable bulbs were in the bedroom, bathrooms, kitchen, and garage. It is important to note that most lower consumption homes will probably consist of 1 or 2 rooms that function as the bedroom, kitchen, dining room, living room, etc.

The survey also included questions on consumer attitudes and familiarity with CFLs. Unfortunately, there were too few respondents to draw statistically valid conclusions. Some of the indicative results are discussed next.‡

Monterrey customers seemed to be more acquainted with the CFLs. Almost 30% of Monterrey households owned CFLs previously, about 3 times more than in Guadalajara. About 46% of Monterrey households were familiar with CFLs, while in Guadalajara only 19% of households knew of them. This may be due to the multi-year efforts of CFE's Monterrey offices to promote efficiency in the homes, the existence of a CFL manufacturing plant in Monterrey, the proximity to the U.S. (which lends to better transfer of information on innovative technologies), and Monterrey's higher income.

The most important reasons for past acquisition of CFLs were to save energey (62 and 20% in Monterrey and Guadalajara, respectively), to save in their utility bill (about 10%), and for environmental reasons (20 and 7%). Customers were very happy with their CFLs (83 and 88%). They particularly liked CFLs because they save energy (25 and 48%), help the environment (about 12%), and provide better light (20 and 30%). Some customers did not like the high price (12 and 35%), flicker (24 and 16%), and quality (36 and 8%). In both cities, about 93% of households expressed an interest in using CFLs. The minority which objected to CFLs cited their high cost (40 and 54%). Customers also showed a wide variety of preferred acquisition modes. Customers preferred magnetic CFLs (about 52%) because they are cheaper (they were informed by the surveyors that they cost about half what electronic CFLs do); their slower turn-on time was less important. Finally, CFL programs will need to offer a variety of purchasing and financing options. Interestingly, about 44% of the Guadalajarans would prefer to buy the CFL outright rather than enter into a lease/rent scheme. This shows their distrust of official government, which was also evident in their attitude toward the surveyors.

RECOMMENDATIONS FOR HOUSEHOLD LIGHTING SURVEYS

Here we briefly describe the main lessons learned in both the survey implementation and its analysis. Excellent references on household energy surveys exist for detailed descriptions of the basics of household energy surveys.[20,21] We recommend that these should be studied in advance.

Define objective clearly

Before going into all the details (questionnaire, strategy), it is important to define the objectives of the survey in detail and seek agreement on these from all the participants in the project. In the case

†All of Mexico's households pay the same six-tier, increasing-rate tariff (Tariff 1), during the six Winter months. During the six Summer months, households are grouped into five different six- or seven-tier, increasing-rate tariffs (Tariff 1–1D), according to the average maximum ambient temperature. The higher the ambient temperature, the higher the allowed monthly consumption is before the higher rate is applied. Guadalajara is in Tariff 1 all year long. This tariff is also applied to 12 million residential users. Monterrey is in Tariff 1B and is assumed to represent the average situation of the 4 million residential users in Tariffs 1A–1D.

‡Percentages reported relate to number of respondent households and not to the total size of the survey. Unless indicated, the first number corresponds to Guadalajara and the second to Monterrey. If only one number is shown, it is representative of both cities.

of Ilumex, this would have ensured that the initial data analysis would have answered all the pertinent questions instead of subsequent additional analysis effort.

Allow sufficient time to do the survey carefully

Surveys are difficult endeavors and care needs to be taken to ensure there is enough time for all the tasks. This is particularly important in a developing country where basic infrastructure (i.e., quality customer data bases that have updated records of user, address, and consumption; and good transportation) is not always available. In the case of Ilumex, due to time constraints (so that survey results could be used in a broader feasibility study), the survey had to be done very quickly. This time constraint created two main problems: (1) it forced surveying outside of the initial sample list due to non-existant addresses in the utility generated customer list (these non-sample surveys would be usable once annual consumption data were obtained from the utility); and (2) it did not allow supervisors enough time to analyze the incoming surveys and detect problem surveyors before spurious responses to questionnaires were received.

Good and constant communication among all parties is crucial

This is the best way to ensure that all participants are clear on the survey's objectives and their responsibilities. Good communications can help avoid misunderstandings on the objectives of the survey.

Design and review the whole survey process to identify activities

In the case of Ilumex not enough attention was given to the way survey data were going to be stored and processed electronically. This resulted in insufficient computer capability, and the use of both PC and Macintosh systems to process data, which led to problems in data synthesis.

Sample design will depend on circumstances

A geographically stratified survey works best if adequate transportation is available. For large cities, this implies either good public transport infrastructure or at the most 2 surveyors per automobile. If transportation is a problem, it is better to use a survey sample based on representative neighborhoods. In Ilumex, no difficulties were experienced while using the geographically stratified approach in Monterrey, where all surveyors had their own transportation. In Guadalajara, it was much harder to implement, mainly because surveyors used public transportation, but also because some parts of the city were hard to reach as a result of the metro works and/or the continuing impact of the gas explosion a few months earlier. We believe that the geographically stratified method should present fewer problems in small cities and towns, but would require that the surveyors have access to good transportation. Another complicating factor (in the case of Guadalajara) was that the numbering of the addresses did not follow any consecutive order, which made locating the target households difficult.

The questionnaire must be clear and easy to fill out

The use of graphical images was very beneficial in Ilumex to allow surveyors and members of the household an understanding of the different fixture types of interest. The questionnaire must permit the entry of data for homes with multi-function rooms. If the surveys are to identify potential rooms where CFL opportunities exist, the questionnaires must allow the identification of this situation in which a large number of homes will have one or two multi-function rooms.

The pre-test of the questionnaire is essential

In Ilumex, it allayed fears that the questionnaire was too long. It also pointed out some questions surveyors might be asked, which were then incorporated in their training. Finally, it showed that some format modifications were necessary to facilitate data entry.

Previous knowledge by the household of the survey is extremely helpful

In Monterrey, most of the households knew of the survey and surveyors were very well received. In Guadalajara fewer homes were contacted before the survey due to the lack of resources at local CFE offices. This, together with a locally high distrust of government entities and strangers, impaired access.

Surveyors must have identification

In the presurvey test, we were thrown out of a house after gaining entry and beginning a survey by another member of the household who requested proper identification. We suggest that at least the surveyor should have a picture identification card and a copy of the official letter of introduction previously sent to households. Additional means of identification such as uniforms or clearly marked official vehicles, although not needed in Ilumex, could also help.

Training of surveyors is very important

Surveyors should clearly understand the importance of their work and how crucial it is for them to be honest about their own evaluations of the surveys they make. They should have a basic understanding of the technology being deployed and some idea of what to expect in the answers. In this fashion, a surveyor can not only answer any questions the customer might have on the technology (or a telephone number to refer the customer to), but also should be able to query the customer for more appliances if the reported uses are less than expected. Although we initially considered paying a base amount per survey plus a bonus if it was accepted, this proved impossible to carry out in practice due to complications with the contracting.

Optimum composition of surveying team must be determined in the field

We thought we would need to use a woman and man team of surveyors to gain entry to the homes. This was not borne out in Ilumex, where individual surveyors (irrespective of gender) sufficed. In other countries this might not be the case. Entry nevertheless was limited; in most cases surveyors were only allowed into one room of the home. This meant that it was impossible to verify customer responses.

Incentives for households need to be field determined

We had thought that it would be good to have a gift to recompense surveyed households for their time. This proved to be unnecessary since interviewees answered the questions without any knowledge that they would be receiving a CFL as a gift at the end of the survey. On the other hand, leaving the CFL behind not only improved utility public relations, but also opened the possibility of a future survey to examine customer CFL acceptance issues.

Survey data should be reviewed for inconsistencies as quickly as possible

This implies that the data collection and analysis process must be in place before the survey begins. This was not possible in Ilumex due to time constraints. Lack of this capability was partly to blame for the large number of invalidated surveys in Monterrey.

Surveys should try to gather as much relevant data as possible

It is very difficult to gain access to homes every few months, and thus comprehensive surveys are preferable. On the other hand, surveys should not last too long in order to reduce customer inconvenience and ensure good quality answers. The Ilumex questionnaire took half an hour. For example, the data collected in the Ilumex survey on other electric appliances can now be used to design programs to promote efficiency in other major end-uses such as air conditioning in Monterrey.

CONCLUSIONS

The Ilumex survey showed that a limited number of bulbs in Mexican urban homes are easily replaceable with CFLs. This situation will obviously vary among countries depending on the prevalence of incandescent lighting and construction practices. For countries like Mexico, where almost all the residential lighting is with incandescent bulbs and marginal residential electricity rates are very low (mostly under 4¢ /kWh), only 1/6 of the lights will be cost-effective to replace (i.e., in fixtures that can accommodate CFLs easily, that currently have incandescent bulbs of at least 40 W, and that are used a minimum of 4 hours each day). The surveys indicate that 1.7 million CFLs can be economically introduced in the cities of Guadalajara and Monterrey. If the customers have to bear the totality of the costs, then they can only replace those incandescent bulbs used at least 4 hours per day to have a positive net present value of benefit. If the utility shares in those costs, then customers can replace all

incandescent bulbs used at least 2 hours per day, in which case the number of replaceable bulbs can be as high as 3.7 million. The average wattage of the replaceable incandescent lamps was about 67 W. The majority of these were located in the bedroom (about 38%), kitchen (14%), bathroom (14%), and living or dining rooms (around 10 and 8% respectively). Most of the lamps were on during peak load times, implying a potential saving of 78 GW of peak demand at the busbar and 135 GWh per year if 1.5 million CFLs are introduced. Several interesting conclusions can be derived from the CFL attitude questions. Not surprisingly, CFL price was found to be important (consumers preferred magnetically ballasted to electronically ballasted CFLs because of the former's price being about half that of the latter). A significant percent of Guadalajara customers preferred to purchase the CFLs outright and not enter into any financing schemes, while Monterrey customers preferred financing schemes. Thus, a multitude of options should be presented to customers for CFL acquisition. The environmental and energy and monetary savings benefits of CFLs should all be stressed in the advertising campaigns. In doing a survey it is important to allow enough time for all the tasks involved. Constant communication among the participants is essential to ensure an understanding by all of the importance and main objectives of the survey. In large cities where transportation might be a problem, the survey sample should probably be based on representative neighborhoods instead of a city-wide strategy.

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